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ABSTRACT

Significant advances in hardware and software have increased the possible applications for educating limited-English-proficient students. Two major studies have focused on technology and its relationship to the education of this population. There is a great diversity of hardware currently in use in schools, either stand-alone computers or computer networks. Several emerging technologies have potential applications: videocassette recorders, compact disk read-only memory (CD-ROM), videodisks, and computers that recognize speech. There is also a variety of available software in the form of drill and practice, tutorials, simulations, games, and applications of databases, spreadsheets, programming, authoring languages and systems, and word processing. Ideally, software should be both instructional and intellectual, and whatever its use, software should not supplant the teacher but provide new methods and tools for learning. The use of word processing offers a number of advantages for teaching reading and writing to limited-English-proficient students. Factors affecting the successful implementation of technology include lack of appropriate software, inadequate software integration into the curriculum, lack of compatibility between hardware and software or between hardware components, lack of funding to support repairs and maintenance of computer systems, and lack of teacher training. Correction of these problems and increased student and teacher access are recommended. (MSE)

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The Role of Educational Technology in the Education of Limited English Proficient Students

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Introduction

Between 1981 and 1986, the percentage of American schools with computers intended for instruction grew from approximately 18% to almost 96%. There are now more than one million computers in public schools alone, and over 15 million students and 500,000 teachers in public and private schools use computers and related technologies. With so many computers in the schools, one might expect computers to be deeply integrated into the educational process, including classes for limited English proficient (LEP) students. Yet, although 50% of all classroom teachers use computers, only 22% of the regular classroom teachers who teach LEP students use computers (Office of Technology Assessment, U.S. Congress, 1987). The role computers and other educational technologies play in educating LEP students will be examined in this paper.

Computers can no longer be relegated to the role of drill master for those students not achieving proficiency in a subject or as a reward for those who do. Arguments that either the hardware or the software have been inadequate are no longer valid. There have been significant advances in such areas as the processing speed, sound, graphics, and video capabilities of computers. These technological advances in hardware and software have exciting potential applications in educating LEP students. Teachers, administrators, and others involved in the education of LEP students are now able to take advantage of these technological advances.

What does research say about the effectiveness of computers for teaching LEP students?

Two major studies have focused on technology and its relationship to the education of LEP students: *Review of the State-of-the-Art of Educational Technologies Implemented in Programs Serving LEP Students Funded by the Department of Education* (1984, COMSIS) and *Trends and Status of Computers in Schools: Use in Chapter 1 Programs and Use with Limited English Proficient Students* (Office of Technology Assessment, 1987). The findings from these studies will be discussed throughout this paper.

The 1984 COMSIS study, funded by the U.S. Department of Education's Office of Bilingual Education and Minority Languages Affairs (OBEMLA), evaluated the funding request documents for 604 projects and identified 114 projects that used a new technology in their instructional methodology. From the 114 new technology projects, a sample of nine projects was selected and studied in detail.

The two basic technologies represented in the sample were video and computer use. The study found that technology can have a significant positive effect on LEP students. Video technology enhanced instruction because:

- bidirectional television [made] scarce teaching resources available to students that [were] geographically dispersed;
- and the use of videotapes [brought] the outside world into the classroom while giving the teacher a versatile tool that [could] play real life situations, stopping, starting, and replaying as needed to clarify or reinforce specific issues. (COMSIS, 1984).

According to the COMSIS study, while video technology can augment traditional teaching, computer technology can bring a "revolution" in teaching. This is because computers have the potential

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for permitting students to learn at their own speed in a highly motivating and non-threatening environment. The major impediments to the effective use of computers in the schools is the lack of instructionally and technologically sound software and the lack of training in the planning for and use of computers.

The other major study of the use of computers for LEP students, entitled *Trends and Status of Computers in Schools: Use in Chapter 1 Programs and Use with Limited English Proficient Students* (1987), was conducted by the Office of Technology Assessment (OTA), at the request of the U.S. Congress. The OTA study provided a comprehensive review of the literature on technology in the schools and analyzed trends in the distribution of computers, computer access, sources of variation in access, equity issues, racial and ethnic differences, instructional applications of computers, teacher training and experience, and the effects of computers in education.

Although the research tends to support the continued use of instructional technologies in the schools, the study results are mostly subjective. Furthermore, there have been no comprehensive national studies which focus exclusively on the effectiveness of educational technologies for LEP students.

Dr. Henry Becker of the Johns Hopkins University Center for Research on Elementary and Middle Schools has conducted research over the past five years in an attempt to synthesize the research on computer use in schools. He surveyed 8,000 teachers and principals and found that teachers who used computers perceived computers as increasing students' enjoyment of their school experience and motivating them to pay closer attention to academic work (Becker, 1988). However, these survey findings are only perceptions, and not direct measures of the effectiveness of computer use in schools.

To ascertain direct measures of effectiveness, researchers must review more rigorous experimental studies which compare the achievement of students using computers to those not using computers. Becker found that many of the earlier studies examined the use of mainframe or minicomputers, not microcomputers (which are found in most schools today). Moreover, software design and use has changed significantly over the last few years. For example, word processing, which was non-existent in the earlier studies, now constitutes 15% of all computer time (Bracy, 1988). Becker concludes that more research is needed to determine under what conditions and circumstances computers can be effective and is undertaking a three-year national study to provide such information.

What types of hardware configurations are currently used in the education of LEP students?

Computer hardware is the machinery or equipment which allows the software to operate and often consists of a central processing unit (cpu) or the "brain" of the computer, a monitor (the screen), a keyboard, and a printer.

There is a great diversity of hardware configurations currently being used in the schools. Basically, however, they can be divided into two categories: stand-alone computers or computers that are linked together as a network. The majority of schools use a stand-alone approach, where each workstation has an independent computer system with a single keyboard, monitor, and one or two disk drives (generally 5 1/4 inch floppy disk drives). According to the COMSIS study (1984), the decision to use a stand-alone approach was made mostly by default: many projects had inherited computer systems which were already in place.

The placement of stand-alone computers in schools differs greatly. In some schools, each classroom may have one or two computers, whereas in other schools, the computers are centrally located in one computer laboratory. Many schools that do not have the luxury of having enough computers to place a computer in each classroom keep their computers in a lab.

Developing a computer lab requires planning to handle the logistics of scheduling computer use by students, to assure that equipment and materials are available and to incorporate the computer use into lesson plans (Fulton, 1988). Although teachers may intend to meet regularly with the computer lab staff to coordinate lessons and content materials, this initial enthusiasm can dwindle quickly. Many teachers use the time when their students are at the computer lab for an additional planning period or free period; instead, teachers could be using this computer time as an opportunity to learn *with* the students. Not all teachers have the time or resources to take computer classes in addition to teaching full time. Learning is a cooperative activity, and learning about or with the computer is one activity that both teachers and students can enjoy together.

School districts also use computers that are linked together or networked. Computer networks involve connecting several workstations together with cables, so that individual workstations are dependent upon a master workstation. This method of instruction is ini-

tially more expensive than the stand-alone approach, but as the number of workstations increases, networking becomes a more economical approach than an equal number of stand-alone workstations (COMSIS, 1984). However, the cost effectiveness of networked stations may be lost if the expense of installing cables to connect the workstations is high. Moreover, in many school districts with older electrical wiring, it is difficult to receive building maintenance approval for networks. Despite these limitations, it is expected that in the future more school districts will use networked stations.

What are the emerging technologies and how can they be used in the education of LEP students?

There are several emerging technologies which have potential applications for the education of LEP students. The use of videocassette recorders (VCRs), optical-disc technology, such as Compact Disc Read-Only Memory (CD-ROM), and interactive videodisc systems will be discussed below.

Vidoecassette Recorders

The use of videocassette recorders is becoming increasingly common in the education of LEP students. Since many teachers and administrators are familiar with the technical aspects of VCRs, their use has been readily accepted. In some school systems, such as the District of Columbia (D.C.) Public Schools, students are allowed to borrow English as a second language (ESL) tapes to view at home. The teachers found that over 50% of their ESL students had VCRs at home, and administrators hope that lending ESL videotapes for students to view at home will also give the students' family members additional exposure to English.

CD-ROM

Compact Disc Read-Only Memory (CD-ROM) systems use technology which was developed for the audio compact disc industry. These systems store 550 million bytes (a byte is a group of eight "bits" or two digit units, and microcomputer memory capacity is measured in the number of bytes of information it can store) on 4.7-inch discs (Feuche, 1987). In other words, one CD-ROM disc can hold up to 250,000 pages of text (Kuhn, 1987).

CD-ROM systems can be used in education for storing and retrieving large databases, particularly in school libraries. For example, *Grolier's Encyclopedia, Encyclopedia Brittanica, Webster's Unabridged Dictionary,* and *Random House Dictionary* are currently available on CD-ROM. Educational Resources Information Clearinghouse (ERIC), a database on educational research and practices, is also available on CD-ROM format. According to "Educational Computing in America: Electronic Learning's 8th Annual Survey of the States, 1988," 75% of the states plan to embark on new technology related programs in 1988-1989, such as long distance learning, CD-ROM, videodisc, and laserdisc. Currently, CD-ROM players can be found in 20 states in grades 10-12, in 17 states in grades 7-9, and in 15 states in grades K-6 (Bruder, 1988). Although local school districts may still be trying to supply their schools with microcomputers, many of the states are concentrating their efforts on these types of emerging technologies.

In the future, when more libraries will use CD-ROM technology for storing large bodies of information, intermediate or advanced LEP students may benefit from exposure to this medium. For example, these students may use CD-ROM technology to provide them with information for book reports or essays. However, beginning ESL students may not be able to benefit as much, since much of the information stored on CD-ROM systems requires a high level of English proficiency.

Videodiscs

The use of videodiscs, or interactive video, is another emerging technology which has great potential for the education of LEP students. Videodisc systems store video pictures, still pictures, and sound on discs that users can control with a videodisc player or, in some sophisticated systems, with microcomputers (Brandon, 1988). These systems can provide the interactive capabilities of computers and the motion-picture capabilities of videos. For LEP students, interactive video is particularly appropriate because it can create a multisensory, multidimensional language center that is specially tailored to their needs. With interactive video, ESL students can extrapolate information from contextual and non-verbal cues in addition to reading. Interactive video can be an excellent instructional delivery system for LEP students because it:

- enhances cooperative learning, offers the drama of live-action video, provides immediate feedback, elicits overt behaviors, and makes reading an active and interactive process;

- combines text, graphics, animation, audio, still frame slides, and moving video segments in any combination; and
- can be used for individualized remediation. (Katsareas, 1988)

Although interactive video may be an exciting approach for teaching LEP students, the initial cost of the system may be prohibitive for many school districts. School districts may also decide to produce their own interactive video, since there are few videodiscs available for use with ESL students. However, they should be cautioned that interactive videodisc development involves more sophisticated knowledge of instructional design because production occurs on two levels: the making of a successful video and the programming of a computer to interface with the video (Hamilton & Katsareas, 1988).

Two videodisc programs which have been used with LEP students include *PALS* and *Skillpac*. The *Principle of Alphabet Literacy System (PALS)* is an IBM interactive videodisc program which teaches literacy to adults. *PALS* was designed to teach basic literacy to low literate or illiterate native English speaking adults (from 0 - 4th grade reading levels). The first phase of *PALS* uses a fictionalized story of the invention of the alphabet in 3100 B.C. Some instructors have commented that the vocabulary of the *PALS* myth is too idiomatic for the low literate or illiterate non-native English speaker (Katsareas, 1988).

Skillpac: English for Industry is another interactive videodisc system which has been used with LEP students. *Skillpac* teaches ESL and cultural skills in a vocational context appropriate for the petroleum, construction, and other industries. Different versions for native Spanish and Portuguese speakers have been used with displaced workers in Massachusetts. *Skillpac* may be useful with LEP students at the high school level in vocational education classes, since the materials provide visual images as well as opportunities for listening in context, which is critical for effective language learning (Grognet, 1987).

Computers That Talk: Speech Recognition Devices

In recent years, the speech capabilities of computers have increased dramatically, and many computers that "talk" no longer sound like robots. Digitized voice attachments are available for most computers, but there is a great diversity in the quality of speech; some computers sound more like human voices than others. This is because the speed of processing (including the storage capacity of the system) and the type of processing vary. However, at the present time, there is a time lag between the availability of the digitized voice attachments and software which capitalizes upon the new speech/voice capabilities of computers. Presently, there is a great deal of excitement, as educators await software like *Reader Rabbit* and *Writer Rabbit* for the Apple IIGS system. LEP students would be able to hear what they have written on the computer screen in addition to seeing it. The advanced voice capabilities of computers like the Apple IIGS system will greatly enhance ESL instruction as more "talking" software becomes available.

Writing to Read is an example of a program which uses the capabilities of an IBM Personal Computer with a digitized voice attachment. *Writing to Read* has received nationwide attention and has been implemented in school systems across the country; administrators and teachers have consistently reported dramatic results. In 1988, IBM released a manual of the *Writing to Read* program adapted for LEP children, developed by Dr. John Henry Martin. One of the reasons for this program's success with LEP students may be that it is a multimedia, multifaceted instructional delivery system consisting of five components: 1) Computer Station, 2) Work Journal Station, 3) Listening Library Station, 4) Writing/Typing Station, and 5) Make Words Station.

Some of the educational principles and practices that make *Writing to Read* effective for language acquisition are as follows:

- It operates in a positive, highly supportive environment which models language rather than corrects it.
- Students can progress at their own pace and control their own learning.
- Personal experiences and cultures are valued and used as a context for listening, speaking, reading, and writing.
- The program emphasizes concrete, multisensory activities.
- The program takes a developmental rather than a remedial approach to learning.
- The computer and other learning materials are used for skill development, creativity of expression, interaction, and natural communication.
- Listening is considered basic to learning and a variety of listening opportunities are provided.

- The program capitalizes on existing language skills and does not demand that students read or write anything they cannot say or understand. (IBM, 1988).

What types of software are available and how are they being used in the education of LEP students?

There is a variety of software available for use with LEP students. Software, which gives the computer instructions (and is often thought of as the material which is on the floppy disk), has been grouped into the following five major categories: drill and practice, tutorials, simulations, games, and applications. The types of software are described below, along with possible applications for the instruction of LEP students.

Drill and Practice

The most common type of instructional software used in education, (including the education of LEP students) is drill and practice. According to Becker (1985), students in lower socioeconomic status schools typically spend more time with drill and practice software than students in higher socioeconomic status schools. Moreover, low-achieving students use computers to practice and reinforce basic skills (which are often the focus of drill and practice programs), while high-achieving students concentrate more on programming and problem-solving skills.

Drill and practice software is often described as the "electronic textbook," where students can work on questions and answers, substitutions, or completion exercises and answer by typing a letter, number, word, phrase, short sentence, or lines of text (Cubillos, 1984). Although drill and practice software is not the most interesting form of interactive instruction, it is still useful. For example, if one student needs additional practice on the past tense in English grammar and another student has mastered the past tense but needs reinforcement with the future tense, drill and practice software programs can provide both students with as much reinforcement as necessary at the same time. The computer will continue to review the same material over and over again until each student has mastered the concept that needs reinforcement, whereas the classroom teacher may not have sufficient time or patience. In many instances, ESL classrooms have students with different proficiency levels; students can work at their own level on the computer to reinforce the principles the teacher has taught (while the teacher can continue to work with those students who have the most difficulties).

Drill and practice software has become increasingly sophisticated over the years. In many cases, teachers can create their own vocabulary lists and individualize the content of the lesson. Also, many programs provide recordkeeping procedures where teachers can review the progress of individual students.

Drill and practice in its most positive application can give students more time on a task: students can practice at their own pace without pressure until they fully master the concept. However, some educators feel that this type of software provides less instruction than a classroom teacher who can provide constant human interaction.

Tutorials

Tutorials are similar to drill and practice programs, except that they have the additional capability of branching to various areas, depending upon students' individual needs. For example, if a student has answered several questions in a row incorrectly, the program may branch into an easier group of questions. On the other hand, if a student answers several questions in a row correctly, the program may branch into more difficult questions. Tutorials, unlike drill and practice, actually tutor, so that they teach concepts and provide explanations. They capitalize on the ability of the computer to indivualize instruction to meet the unique needs of each learner.

Simulations

Simulation software simulates actual situations and can be used for classroom activities. Simulations are particularly common in the sciences, where it is sometimes difficult to provide real life experiences. For example, the software program called *Operation Frog* allows students to dissect a frog on the computer. Simulations can be particularly useful in the education of LEP students, since there is often a shortage of science equipment and supplies designed for them. However, many simulations are complicated programs which require a high level of English proficiency to operate, making them difficult for some LEP students. Simulations could be used more widely if the software had simpler directions for LEP students. Many teachers make their own summary sheets of how to use the software. These summaries can be used in ESL instruction as well as to provide better operating instructions for the ESL students. More simulation

software is needed for the LEP population, but simulations often require more computer memory than do other software programs, and thus may tax the limits of many schools' equipment.

Games

Educational games, which provide instruction as well as entertainment, are another type of software. Generally, educational games are designed to take advantage of the graphic capabilities of the computer, which tend to engage students. Educators must take care to find games which are educational; often students want to play computer games which are only entertainment. Educational games can be used effectively with LEP students because there is often less text on the screen than with other software programs. For example, beginning students who do not have many English language skills can benefit from educational games, where instruction is reinforced through graphics.

Applications

Software applications include databases, spreadsheets, programming, authoring languages and authoring systems, and word processing. Databases, which can be thought of as computerized card catalogs (with each card in the catalog similar to one computer record), can be used to teach concepts such as categorization and grouping. An example of this can be found in the National Clearinghouse for Bilingual Education Program Information Guide No. 5, *Using Computer Concepts as Problem-Solving Tools in the Language Classroom* (1988), which provides instruction on using these concepts in mathematics classes. With the use of databases, students can learn many skills at the same time such as grouping, the content of the groups, and vocabulary, as well as the computer skills necessary to manipulate the information in a database. Some database programs used by LEP students, such as *Bank Street Writer* and *AppleWorks,* can be purchased with prepared databases. Such databases include U.S. cities, U.S. Presidents, or mammals, which can be used to teach social studies, history, and science, respectively.

Spreadsheets, often thought of as computerized account ledgers, can be used to teach mathematics skills and to practice computations. In addition, spreadsheets can provide older LEP students with practical survival skills such as monthly budgeting and accounting.

In the early years of computing, instead of using the computer to work with content areas, programming was the most common use of the computer. Programming, where students give instructions to the computer that are converted through the programming language into individual machine instructions, controls the operation of the computer (COMSIS, 1984). The early emphasis on programming stems from the fact that most computer teachers were programming enthusiasts themselves and there was little educational software available (OTA, 1987). Moreover, in the past, computer lab coordinators in many schools were mathematics teachers, since they were required to take one or two programming courses as part of their mathematics certification.

There are several different programming languages which are currently used in schools, such as BASIC, Logo, and Pascal. Programming can be used in the classroom as an effective way to develop students' logical and critical thinking skills. However, since it requires that the computer teacher have more sophisticated knowledge of computers, teaching programming can be more difficult to implement than using drill and practice software.

In "The Many Myths of Programming" (1988), Ohler dispels the myth that programming should be thought of as a skill students need to become computer literate or to be prepared to enter the workplace:

"As application packages have become more powerful and commonplace, the need for and practicality of do-it-yourself programming solutions has dwindled dramatically. The market-driven economy now supports many more positions for those who are skilled application users than programmers." (p. 22)

Authoring systems and authoring languages are similar to programming, but require less knowledge of computers. With an authoring system, the teacher provides the content and makes some pedagogical decisions, but cannot alter the basic instructional design of the system. For example, an authoring system could generate multiple choice quizzes and tests or cloze exercises from typed-in text. The program gives all the instructions, and the teacher enters explanatory texts, questions, right answers, and hints. Meanwhile, the program provides screen presentation, branching, and scorekeeping (Higgins and Johns, 1984). While the systems are more versatile, offering more control and more flexibility to the teacher who has taken the time to master the "code," the software itself requires much more learning time (Mydlarski and Paramskas, 1984). In the D.C. Public Schools, for example,

teachers used the *McGraw-Hill Authoring System* to develop reading comprehension lessons for their beginning ESL students. Since most of the reading comprehension software available was too difficult for their beginning students, the teachers decided to develop their own lessons.

Classroom teachers have quite a variety of tasks to perform, and many may not have the time to learn and apply authoring systems. Since other software programs are becomingly increasingly innovative and sophisticated, teachers may not wish to invest time in learning to use an authoring system.

How is technology being used to teach reading and writing skills to LEP students?

The debate over what types of software should be used in schools and how they should be used (such as teaching programming or word processing) brings up the question of whether software should be used as an instructional tool or an intellectual tool. Software which is instructional merely "instructs," while software which is an intellectual tool is used to develop critical thinking skills or problem-solving skills. Ideally, software should be both instructional and intellectual. However software is used, it should be emphasized that, "technology does not supplant the teacher, but instead provides teachers with new methods and teaching tools. Technology cannot make a poor teacher into a good teacher. Technology can increase the effect and effectiveness of a good teacher, and can make a good teacher a better teacher." (COMSIS, 1984, p. iv).

For LEP students in particular, using word processing and computers has great potential for developing both reading and writing skills. Since the teacher or lab coordinator must provide the text (content) which will be used in word processing, this type of instruction may be difficult for new teachers to implement initially. However, it can be cost effective since the program itself can be used for many different content areas (unlike, for example, a drill and practice program on adjectives).

Besides the instructional potential of word processing, there are several other advantages to this application: it is relatively inexpensive; it is easy to use; it requires no programming knowledge and limited computer experience; and it is not threatening to most students or teachers (Jex, 1988). Moreover, since word processing is a skill which many students will need to succeed in the workplace, many of them are especially interested in receiving this type of instruction.

In "Microcomputers and English Language Instruction: A Few Years Later," Jex describes the use of the word processor to achieve two instructional goals at the same time: language instruction and word processing. Some examples of the dual functions of the word processor include:

1. At the most basic level of ESL instruction, teachers can create cloze, fill-in-the-blanks, or matching exercises. Students can complete the exercises both on-screen and on print-outs. For example, students can review grammar while learning basic word processing tasks.

2. Once students have mastered the most basic word processing commands, then they can expand their practice to include editing larger language elements. Students can create paragraphs from scrambled sentences while practicing moving small blocks of text with the word processor.

3. When students become comfortable with manipulating small blocks of text, they can refine their organizing skills in preparation for writing. Students can organize sentences or paragraphs into categories such as theme, thesis, and support.

4. Finally, students can shorten, edit, and summarize full-length documents (or essays) using the cut/paste commands. Although beginning ESL students may not have the English language skills necessary to edit long essays or even paragraphs, most educators agree that students are more "engaged" in their learning activities, regardless of the content, when using the computer. In writing, for instance, students seem to write more (judging by word count) when they are writing on the computer. More is not always better, but it is often easier to delete or edit text than it is to create text from scratch. Also, if students are having difficulty in penmanship, the computer allows them to concentrate on the content of the writing as opposed to the act of writing itself. Many times, this improved concentration on content can greatly affect the students' work and general interest in writing.

The use of the computer as an interactive instructional medium can complement the reading-writing process. Using the word processor to teach writing skills obviously involves reading, whether or not reading is identified as the specific area of concentration. Reading and writing (especially original writing) is often a joint process. If the examples of word processing are analyzed, it is clear they require *both* reading and writing skills to perform successfully. In summary,

the reading-writing process when effectively combined with the capabilities of the computer can greatly enhance ESL instruction.

Another outcome of the use of computers to teach reading and writing skills is the increase in teamwork or cooperation noted by many educators. According to McCahill "teamwork at the keyboard is the essence" of this approach (1984, p. 74). In word processing, like many other computer activities, students can work cooperatively. For example, one student can write a poem, essay, or a few sentences and then other students can help edit, rewrite, or critique the document on the printout or on-screen. In this peer-teaching activity, students are less likely to feel threatened, and in many cases, students can be more open and creative than when the teacher reviews or edits their work. Moreover, many students benefit from generating ideas among peers, where they can "brainstorm" with other students.

Computers are also being used to provide ESL instruction through the use of local and long-distance electronic networks. The OTA report cites electronic computer networks (computers which can exchange information through the use of electronic mail systems and modems) such as the New England Multifunctional Resource Center's "Orillas," as an effective way to improve ESL writing skills. The Orillas project arranges for sister classes to exchange writings (and even videos) with their counterparts in Argentina, Mexico, and Puerto Rico (Sayers, 1988). When computers are used to encourage LEP students to write and communicate more effectively in highly functional contexts, both in their native language and in English, they can provide a means for students to break out of the traditional mode of thinking, to enhance their sense of mastery, and to enrich the learning experiences by providing access to role models and speakers from their native culture (OTA, 1987). According to the *Electronic Learning* survey, the state education agencies are focusing on distance learning projects. In 1987-1988, the U.S. Department of Education funded distance learning projects in 33 states (Bruder, 1988).

What factors can affect the successful implementation of technology for LEP students?

In most studies of the implementation of new innovations in education (Jex, 1988; OTA, 1987; Schcolnik, 1987; COMSIS, 1984), the teacher is identified as the participant who is most closely associated with the success or failure of the implementation of new technology. The teacher can encourage or discourage, help or hinder, integrate the computer into the regular classroom activities or isolate it (Schcolnik, 1987). However, the implementation of technology is also affected by other factors which will be described below.

Lack of appropriate software

The most common complaint among educators implementing computers in the classroom is that there is a lack of appropriate software. Many new, excellent programs have been developed in the fields of mathematics, sciences, language arts, social studies, and foreign languages, as well as software utility packages, such as word processing and spreadsheets, which can be used in a variety of content areas. For the LEP population, however, the lack of software is still a concern. In the fields of ESL and bilingual education, the quantity and quality of software designed especially for LEP students lag far behind software developed for other populations. For example, in the 1986-1987 edition of *The Educational Software Selector (TESS)*, out of a total of 6,838 instructional products, only 34 entries were listed under ESL; thus only .005% of the software listed was designed for ESL students (EPIE Institute, 1987). Educators hope that the software industry will realize that the language minority population is the fastest growing school-age population in the U.S., and efforts to provide quality software for this previously "thin" market will increase (Education Turnkey Systems, Inc., 1985).

Software is often not integrated into the curriculum

Not only is there a need for appropriate software for LEP students, but such software would be more useful if it were integrated into the curriculum. However, software that is designed to reinforce discrete tasks is sometimes difficult to integrate. For example, a program which reinforces the past tense may not warrant the preparation time necessary for its successful implementation. Since time and materials are expensive, teachers must look for software which can teach a variety of language skills; a teacher would not use a textbook simply because it reinforces the past tense in English without teaching additional language skills. In time, however, it is expected that more software will become integrated into the curriculum -- educators must remember that the use of computers in the schools is a relatively new technology and it will take time to fully integrate it. Many local school districts and state education agencies are in the process of

correlating specific software programs to their curriculum objectives.

Lack of compatibility between hardware and software or between hardware components

Selecting the appropriate mix of hardware and software is vital to the successful implementation of computer technology in an instructional program (COMSIS, 1984). As in the selection of personal computers for home use, buyers must consider a number of factors such as how the computer will be used, how much memory is required to use programs or applications, and whether or not the system can be upgraded by adding peripherals. School districts must plan ahead and purchase equipment which will continue to meet their computer needs. Anticipating the changes in the needs of the population (for example, selecting computers which are easily upgraded and/or expanded to handle additional memory as the computer applications become more complex and require additional memory) is necessary to ensure the successful utilization of technology.

Lack of funding to support repairs and maintenance of computer systems

Administrators involved in budgeting for technology purchases must always remember that additional funding is needed to support the repairs and maintenance of computers. One method for keeping the computers working when individual components require repairs is to purchase additional equipment. This way, for example, a keyboard can be replaced while the central processing unit remains operational with a back-up keyboard. Although there is not always additional funds for such equipment, it may be appropriate to order additional parts which can guarantee that all computers will be operational at all times.

Lack of teacher training

A major cause of the difficulties in the implementation of technology is the lack of sufficient teacher training, both preservice and inservice. If teachers are to successfully integrate computers in their classroom, teachers themselves must learn about computers. In many school districts, when the computer "guru" (the expert teacher or the one enthusiast who seems to know everything about computers) leaves the school system, the rest of the program suffers. Without proper direction and training, the instructional program dwindles until another computer expert joins the staff.

To successfully use computers in the education of LEP students, teachers must receive sufficient instruction on the use of computers. Sufficient instruction includes preservice training, inservice training, and continuous support. Despite the presence of computers in almost all K-12 schools nationwide, only half of the nation's teachers report ever using computers in instruction (Fulton, 1988). Training is often referred to as the hidden cost of computers, and the needs for training and education are much more extensive and complex than was imagined when computers were first introduced in schools. According to some teacher trainers, teachers have remarked that they were "entertained, not trained" (Taitt and Buxton, 1988). Most teachers are required to have some type of training on computers, but much of this training in the past has been devoted to programming. Teachers need to receive training on how to review and evaluate software for implementation in the classroom as well as how to successfully integrate technology into the curriculum. In addition, teaching with technology requires a different set of skills (the ability to move back and forth between lecturing and coaching) than does traditional instruction. Teacher trainers must provide ample time for teachers to practice these skills.

Recommendations for future directions

Provide additional teacher training and support

Ongoing training and support must be provided in order for the programs to succeed and maximize the effectiveness of technology as an instructional medium. For example, teachers should be encouraged to take courses related to computers (not just programming) and should be rewarded for their efforts.

Although there are computer coordinators at the state and local levels, often the staff does not have sufficient time to devote to each and every school. Many times the programs are set up without the necessary follow-up. Since this is a new technology, involving equipment which needs consistent care and maintenance, follow-up is critical to keep hardware running smoothly. Local school districts should provide workshops for teachers on troubleshooting hardware and software problems, so that the initial troubleshooting can occur before the technical support staff comes to the school, only to find that the computer is unplugged or the monitor needs a simple adjustment.

Develop software appropriate for the LEP population

School districts could maintain closer ties to the software industry to ensure the appropriateness of product design. The tradition of software being created by programmers who are not practitioners to be used by teachers who do not have expertise in instructional design for technology may not have provided the most pedagogically sound materials.

A possible long-term project for school districts could be to provide grants as seed money to software companies for the development of products. In return, the school districts would field-test the software and then buy it for their district at a discount.

Fund further research, including exemplary programs with computer components

At the federal and state levels, additional funding could be provided for comprehensive studies on the effectiveness of the various emerging technologies in the education of LEP students, as well as for exemplary programs which use this technology, such as long-distance learning and interactive videodiscs.

Ensure that students have equal access to computers

Although 50% of all classroom teachers use computers, only 22% of the regular teachers who teach LEP students use computers (OTA, 1987). That the percentage of teachers who use computers to teach their LEP students is consistently less than half the percentage of teachers who use computers to teach other students points to a question of access, both quantitative and qualitative. LEP students need equal access to computers, and more importantly, should have the same qualitative access to computers as other students. All students deserve the same opportunities to use computers with the same computer applications.

Establish a central location for reviewing software

At the present time, the National Clearinghouse for Bilingual Education (NCBE) disseminates information on educational software. Evaluations of software are collected through reviewing various journals, trade magazines, and newsletters, and are listed in the NCBE database MICRO. This database is searchable online, and searching is free of charge (contact NCBE for additional information). A system for distributing software for review by practitioners in the field could be established.

Conclusion

This paper highlights some of the current research on the uses of computers in the schools, the types of software being used in the education of LEP students, some current uses of technology (such as interactive video, word processing, and electronic networks) to teach reading and writing skills, and emerging technologies which may merit future consideration. Further research is needed on a regional or national scale to determine the effectiveness of these various technologies for LEP students. Factors which may affect the implementation of computers for LEP students include: lack of appropriate software, lack of integration of software into the curriculum, lack of compatibility between hardware and software or between hardware components, lack of funding to support repairs and maintenance of computer systems, and, perhaps most importantly, lack of teacher training. Although there are many factors which may affect the successful implementation of technology in the schools, the most important factor in technology is the human factor.

Even if the computer can be beneficial in assisting students to master language skills, it is not the universal panacea, nor is it as versatile as the human teacher (Holmes and Kidd, 1982). It would be impossible to successfully implement technology in the schools without the help of caring teachers who can provide the environment which all students need to develop to their full potential.

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